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6. AUTHOR(S) Professor T.H. Geballe				7. PERFORMING ORGANIZATION REPORT NUMBER F49620-83-C-0014	
8. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Dept of Applied Physics Stanford University Stanford, California 94305				9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFODR BLDG 410 BAFB DC 20332-6448 AFOSR-TR-00 0736	
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The important issue of how the superconducting transition temperature T_c in disordered systems changes near the M-I transition where strong localization ($k_F l \ll 1$) is expected has been studied in the Mo-Ge system. In the high Mo concentration, which is in the weakly localized regime, T_c decreases linearly with decreasing Mo concentration, from 7.5°K (78 at.% Mo) at a rate of $\sim 0.18^\circ \text{K/at.}\% \text{ Mo}$. In this region the ratio of electron-phonon coupling constant λ to the bare density of states $N_0(0)$ is constant, which is consistent with the Varma-Dynes tight-binding model. An extrapolation of the linear behavior of T_c in this regime yields the disappearance of T_c near 35 at.% Mo. However, measurements show that T_c exists down to 13.5 at.% Mo. A non-superconducting metallic phase is found to exist between 13.5 at.% Mo at which concentration the insulating phase occurs.

Superconductivity in very thin films of niobium has been investigated. By use of the ion gun which has been installed in the evaporator it has been possible to identify 3 separate mechanisms which contribute to the reduction in T_c as the film thickness is decreased, namely lifetime broadening, proximity effect and localization. Then upon elimination of the first two, the effect of localization in the weakly localized limit is found to agree quantitatively with theory except for $\leq 15 \text{ \AA}$ where the fall off of T_c is less than expected.

A small single grid ion source has been constructed in order to promote the growth of metastable films at low temperatures. A high flux of N_2^+ at energies as low as 20 eV has been achieved. Studies indicate that the ion beam promotes the growth of single crystal AlN compounds at lower temperatures. Preliminary studies on the growth of transistor metal nitrides have been initiated.

Progress has been made on a new ultra high vacuum M.B.E. evaporator being constructed at Stanford with funds from the DOD Instrumentation Program. A vendor has been selected and a purchase order made for the design-study of the load-lock/transfer arm and substrate configuration. This is the most sensitive and critical part of our unique concept of load-locking and transferring the complete substrate configuration into and out of the evaporation chamber. Sputtering of molybdenum disulfide onto the disassembled parts - balls, races, and retainers has been chosen as the first step in improving the reliability of the ball bearings used in the present method of evaporation rate control.

(Ind)

ANNUAL TECHNICAL REPORT

FOR

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Contract No. F49620-83-C-0014

1 October 1984 - 30 September 1985

SUPERCONDUCTING THIN FILMS, COMPOSITES AND JUNCTIONS

by

Professor T. H. Geballe
Principal Investigator

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH(AFSC)
OFFICE OF ASSISTANT CHIEF
OF STAFF FOR RESEARCH AND DEVELOPMENT
This report has been reviewed and is
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Information Division

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Stanford University
Stanford, California 94505

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GL Report 3954

November 1985

Interim Technical Report - Contract No. F49620-83-C-0014
PI: T. H. Geballe

Persons working on contract during the period 1 April 1985 - 30 September 1985

Hammond, Robert H.	Senior Research Associate
Mael, David	Ph.D. expected Summer 1986
Broussard, Phillip	Ph.D. expected Summer 1986
Park, Sung	Ph.D. expected Summer 1986
Kent, Andrew	Ph.D. expected Summer 1987
Oh, Byungdu	Ph.D. expected Summer 1987

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PUBLICATIONS

1 April 1985 to 30 September 1985

1. "Structural, Magnetic and Transport Properties of Fe/Cr Multi-layer Films," P. H. Dickinson, D. J. Webb, K. Parvin, T. H. Geballe and R. M. White, Bull. Am Phys. Soc. 30, 350 (1985).
2. "T_c Depression in Thin Nb Films," by S. I. Park and T. H. Geballe, presented at the Materials and Mechanisms of Superconductivity Conference, Ames, Iowa, May 29-31, 1985.
3. "A New Look at the Growth of Thin Films of Nb-Sn," F. Hellman, J. Talvacchio, T. H. Geballe, and A. F. Marshall, to appear in Adv. Cryog. Eng. 32 (1985).
4. "The Formation of the Metastable Phase Nb₃Al by a Solid State Reaction," by R. Bormann, H. U. Krebs, A. D. Kent, to appear in Adv. Cryog. Eng., Vol. 32.(1985)
5. "A Thermometer for Fast Response in Cryogenic Flow," by Beverly Louie, Ray Radebaugh, and Stephen R. Early, to appear in Adv. Cryog. Eng. (1986)

Committees

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Solid State Science Committee

Ad Hoc Committee for NSF-MRL Directors

Member, Editorial Board of Chinese Physics, AIP

Member, Editor for Materials Letters, North Holland Publishing Company,
The Netherlands

Member, Committee for the American Physical Society International
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Member, Advisory Board of the Miller Institute for
Basic Research in Science

Member, Program Committee for meeting on "Materials and Mechanisms
of Superconductivity" in Ames, Iowa 5/29-31/85

Member, Board of Reviewing Editors, Science Magazine, American Association
for the Advancement of Science

Scientific projects are being carried out in close collaboration with
industry

R. M. White, Control Data, Minneapolis, MN

J. Boyce, Xerox Corp., Palo Alto, CA

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J. M. Rowell, Bell Commun Res., Murray Hill, N. J.

C. W. Hull, Bell Commun. Res., Murray Hill, N. J.

M. Hong, AT&T Bell Labs, Murray Hill, N. J.

W. P. Lower, AT&T Bell Labs, Murray Hill, N. J.

R. Greene, IBM, San Jose, CA

J. Harper, IBM, Yorktown Heights, N. Y.

A. Braginski, Westinghouse Research Ctr. Pittsburgh, PA

A. Greene, Naval Res. Lab., China Lake, CA

V. Rehn, Naval Res. Lab., China Lake, CA

New discoveries, inventions or patent disclosures

NONE

Visitors and Seminars

1. J. Pannetier, Low Temperature Group, CNRS Grenoble,
"Quantum Interference in Normal Metal Rings and Other
Results from Grenoble"
April 1, 1985
2. S.J. Allen, AT&T Bell Laboratories,
"Hot Electron Dynamics in Semiconductor Microstructures by Far Infra-
Red Spectroscopy"
April 5, 1985
3. W. Nellis, Lawrence Livermore Labs, April 5, 1985
4. M. Tigner, Cornell University, Dept. of Physics, Visiting UC Berkeley,
AP Colloquium, April 10, 1985
5. R. Hubener, Universitat Tubingen,
"Scanning Electron Microscopy at Low Temperatures"
April 11, 1985
6. R. Landauer, Thomas J. Watson Research Center, IBM,
"Fundamental Physical Limits of Computation"
April 17, 1985
7. J. Cahn, National Bureau of Standards, April 18-19, 1985
8. H. Stormer, AT&T Bell Laboratories,
"Fractional Quantum Numbers in Solid State Physics"
May 1, 1985.
9. A. Kamijo, Fundamental Research Labs, NEC Corporation, May 17, 1985
10. U. Walter, Physikalisches Institut der Universitat zu Koln, May 17, 1985
11. K. Murata, Electrotechnical Laboratory, Umezono, June 6-7, 1985.
12. W. Godacker, Institut fur Technische Physik, Kernforschungszentrum,
June 5-6, 1985
13. L. Dubrosavljevic, Institute of Physics, Zemun, July 20-23, 1985.
14. J. F. van der Veen, FOR-Institute for Atomic and Molecular Physics,
Amsterdam,
"Surface Melting"
August 5, 1985
15. J. H. Wernick, AT&T Bell Labs, August 22, 1985

Interim Technical Report - Contract No. F49620-83-C-0014
Period 1 April 1985 - 30 September 1985 (PI: T. H. Geballe)

Visitors and Seminars (cont.)

16. H. Yamamoto, NIHON University, Shima, August 23, 1985
17. T. Sinjo, Institute for Chemical Research, Kyoto, August 23, 1985
18. H. Tsuge, Microelectronics Research Laboratory, NEC Corporation,
August 23, 1985
19. B. M. Clemens, Physics Department, General Motors Research Laboratories,
August 23, 1985.
20. F. Steglich, Max Planck Institute, Stuttgart, Germany, August 26, 1985.

INTERIM TECHNICAL REPORT
FOR
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Contract No. F49620-82-C-0014
1 October 1984 - 31 March 1985

SUPERCONDUCTING THIN FILMS, COMPOSITES AND JUNCTIONS

By

Professor T. H. Geballe
Principal Investigator

Department of Applied Physics
Stanford University
Stanford, California 94305

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August 1985

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PUBLICATIONS

(1 October 1984 - 31 March 1985)

1. "Further Investigations of Solid-Liquid Reaction and High-Field Critical Current Density in Liquid-Infiltrated Nb-Sn Superconductors," by M. Hong, D. M. Maher, M. B. Ellington, F. Hellman, T. H. Geballe, J. W. Ekin and J. T. Holthuis to appear in the Proceedings of the Applied Superconductivity Conference, San Diego, CA 9/84.
2. "The Effect of Non-Hydrostatic Strain on the Superconducting Properties of In-Situ Formed Cu-Nb₃Sn Filamentary Composites," by J. Bevk, W. A. Sunder, F. Hellman and T. H. Geballe, to appear in the Proceedings of the Applied Superconductivity Conference, San Diego, CA 9/84.
3. "Origin of the B_{c2} Enhancement in Ternary Nb-Sn Phases," by R. Bormann, D. Y. Yu, R. H. Hammond, A. Marshall and T. H. Geballe, to appear in the Proceedings of the Applied Superconductivity Conference, San Diego, CA 9/84.
4. "Phase Transformations in Metastable Nb-alloys," by R. Bormann, D. Y. Yu, R. H. Hammond, A. Marshall and T. H. Geballe, to appear in the Proceedings of the Applied Superconductivity Conference, San Diego, CA 9/84.
5. "Specific Heat of Thin Film Amorphous Molybdenum Based Alloys," by D. Mael, W. L. Carter, S. Yoshizumi and T. H. Geballe, accepted to Phys. Rev. B.
6. "Specific Heat of Niobium-Zirconium Multilayers," by P. R. Broussard, D. Mael and T. H. Geballe, Phys. Rev. B 30, 4055 (1984).
7. "Unusual Variability of the Lattice Constant in Polycrystalline Epitaxial Growth of Superconducting Al₁₅Nb-Si," by R. . Feldman, T. H. Geballe, R. L. Opila and S. Celaschi, submitted to Thin Solid Films.
8. "The Metal-Insulator Transition and Superconductivity in Amorphous Molybdenum-Germanium Alloys," S. Yoshizumi, D. Mael, T. H. Geballe and R. L. Greene, submitted to Mott Festschrift. Physics and Chemistry of Disordered Systems and Metal-Insulator Transitions Insulators.
9. "Conversion Electron Mossbauer Study of Thin Nb₃Sn Films," by C. W. Kimball, P. P. Vaishnava, J. L. Matykievicz, F. Hellman and T. H. Geballe, Bull. Am. Phys. Soc. 30, 608 (1985).

10. "Strain Mechanisms in Superconducting Nb₃Sn Compounds," J. Bevk, W. A. Sunder, F. Hellman and T. H. Geballe, Bull. Sm. Phys. Soc. 30, 608 (1985).
11. "Magnetron Sputtering of A15 Compound Nb-Sn," by A. D. Kent, F. Hellman, and T. H. Geballe, Bull. Am. Phys. Soc. 30, 608 (1985).
12. "Growth of "Single Crystal" A15 Nb-Sn Thin Films," by F. Hellman, A. F. Marshall and T. H. Geballe, Bull. Am. Phys. Soc. 30, 607 (1985).
13. "Sputtered Niobium-Tantalum Multilayers," P. R. Broussard and T. H. Geballe, Bull. Am. Phys. Soc. 30, 349 (1985).
14. "Microchemical Analysis of High-T_c A15 Structure Films," J. Gregg, J. R. Gavaler and F. Hellman, Bull. Am. Phys. Soc. 30, 608 (1985).
15. "Epitaxy and Texture of A15 Films on Sapphire," by A. F. Marshall, F. Hellman and B. Oh, to appear in the Proceedings of the Fall MRS Meeting (1984).
16. "Phase Relationships and Superconducting Properties of Ternary Systems Used in the Bronze Process," Rudiger Bormann, Adv. Cryogenic Engineering 30, 659 (1984).

Interim Technical Report - Contract No. F49620-82-C-0014
Period 1 October 1984 - 31 March 1985 (PI: T. H. Geballe)

Visitors and Seminars

1. D. McWhan, AT&T Bell Labs, January 15, 1985
2. D. Mitchell, NSF & LBL, February 7, 1985
3. P. W. Anderson, Princeton University, February 8, 1985
4. S. Schultz, University of California, San Diego,
February 21-22, 1985
5. P. Grant, IBM Research, San Jose, February 25, 1985
6. R. Greene, IBM Research, San Jose, February 25, 1985.
7. D. Face, University of California, Berkeley, March 4, 1985.
8. J. Krim, University of Marseille,
"Wetting and Non-Wetting of Rare Gases on Au and
Graphite: Recent Results"
February 21, 1985
9. J. Talvacchio, Westinghouse Research Labos
"Recent Thin-Film Research at Westinghouse"
April 26, 1985

Interim Technical Report - AFOSR Contract No. F49620-C-0014
Period: 1 October 1984 - 31 March 1985 (PI: T. H. Geballe)

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Solid State Science Committee

Ad Hoc Committee for NSF-MRL Directors

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Member, Editor for Materials Letters, North-Holland Publishing
Company, The Netherlands

Member, Committee for the American Physical Society International
Prize for New Materials

Member, Advisory Board of the Miller Institute for
Basic Research in Science

Member, Program Committee for meeting on "Materials and
Mechanisms of Superconductivity" in Ames, Iowa 5/29-31/85

Scientific projects are being carried out in close collaboration
with industry

R. M. White, Control Data, Minneapolis, MN

J. Boyce, Xerox Corp., Palo Alto, CA

J. H. Wernick, Bell Commun. Res., Murray Hill, NJ

J. M. Rowell, Bell Commun. Res., Murray Hill, NJ

C. W. Hull, Bell Commun. Res., Murray Hill, NJ

M. Hong, AT&T Bell Labs, Murray Hill, NJ

W. P. Lowe, AT&T Bell Labs, Murray Hill, NJ

R. Greene, IBM, San Jose, CA

J. Harper, IBM, Yorktown Heights, NY

A. Braginski, Westinghouse Research Ctr., Pittsburgh, PA

A. Green, Naval Res. Lab., China Lake, CA

V. Rehn, Naval Res. Lab., China Lake, CA

New discoveries, inventions or patent disclosures

NONE

Interim Technical Report - Contract No. F49620-82-C-0014
PI: T. H. Geballe

Persons working on contract during the period
1 October 1984 - 31 March 1985

Hammond, Robert H.	Senior Research Associate
Hellman, Frances	Ph.D. expected Summer 1985
Mael, David	Ph.D. expected Summer 1986
Broussard, Phillip	Ph.D. expected Summer 1986
Park, Sung	Ph.D. expected Summer 1986
Kent, Andrew	Ph.D. expected Summer 1987
Oh, Byungdu	Ph.D. expected Summer 1987